APPENDIX A
HARVEST AND WATER YIELD ANALYSIS SUMMARY

This section includes the results of spatial analysis conducted for the Prospect Creek watershed to analyze timber harvest and road building activities that could potentially affect the hydrology and runoff regime of the watershed. The information provided within this appendix provides additional insight into the current morphology and habitat conditions throughout the watershed. It also provides a reference to compare future harvest activities and outcomes against. Two sets of analyses are included: harvest activity analysis summary and water yield analysis. The analysis period is 1940 through 2003.

Harvest Analysis Summary

Vegetation communities in the Prospect Creek watershed have experienced several changes related to natural events and human activities. Logging of Lower Clark Fork River tributaries began in the late 1800s with the removal of accessible cedars and other species useful for building materials. Cedar stumps in the Clear Creek and Wilkes Creek sub-watersheds, and mainstem Prospect Creek, attest to the size of the mature cedars that once shaded the streams, contributed woody debris, and maintained bank integrity. Although some areas have experienced cedar recolonization, other reaches are now populated by Douglas fir and spruce. While these species provide several of the benefits attributed to cedars, the smaller conifers offer reduced channel shading, channel complexity, and bank stability.

Spatial analyses were conducted to describe the recorded harvest activity that has occurred during the twentieth century. Data used included the USFS TSMRS (Timber Stand Management Recording System) and a GIS layer of stand polygons, also provided by the Lolo National Forest. The data and results reflect harvest activity that has occurred primarily on National Forest which represents approximately 94% of the total watershed. Similar data for timber harvest on private land is not available, and the results presented below do not therefore included harvest activity that has occurred on privately owned land.

TSMRS records acres treated per stand. Stands are typically delineated by a silviculturist using air photo interpretation. A stand is typically a group of trees with similar characteristics in species composition, age and structure. According the USFS timber management handbook (USFS, 2004) a stand is defined as:

"A contiguous group of trees sufficiently uniform in age class distribution, composition, and structure, and growing on a site of sufficiently uniform quality, to be a distinguishable unit, such as mixed, pure, even-aged, and uneven-aged stands. A stand is the fundamental unit of silvicultural reporting and record keeping."

Stand size is highly variable. Stands in the Prospect Creek TMDL Planning Area (TPA) range in size from less than 1 acre to almost 500 acres. Recorded harvest activities in the Prospect Creek TPA through 2003 range in size from 5 acres to 169 acres.

TSMRS records the number of acres (based on slope length) treated within a stand. TSMRS does not record the location of activities within a stand. The number of treated acres based on slope length recorded in TSMRS was used to summarize harvest activities. Comparing the slope-length based treated acres to the total number of acres in a watershed based on planar-area calculations may result in an overestimate of the percent of the watershed treated. Accuracy and completeness of TSMRS database is another limitation. Analyses were conducted acknowledging these assumptions and limitations.

Table A-1 provides a list of the TSMRS activity codes included in this analysis. Activity acreages reflect multiple stand entries if a stand was entered more than once within the analysis period. Activities with accomplishment year 0 were planned activities that had not yet been completed as of this analysis in 2003.

Approximately 18,304 acres (16%) of the watershed have been harvested at least once (**Table A-2**); roughly the equivalent of the entire Clear Creek sub-watershed area. Of this, a little over 8,865 acres (8%) of the watershed was harvested in stands that are in or adjacent to the riparian corridor (**Table A-3**). A riparian-linked stand is a stand that has at least a part of the stand within the 300-foot riparian buffer. Harvest activity may not have occurred in the portion of the stand that is within the riparian buffer. Spatial distribution of activities below the stand level (i.e. within a stand) cannot be determined because, as described above, the minimum mapping unit of the TSMRS database is the stand.

Tables A-1 through A-3 and Figures A-1 through A-6 provide additional harvest summary statistics by year and watershed.

Table A-1. TSMRS Activity Codes Included in Prospect Creek Harvest Analysis

TSMRS Activity Code	TSMRS Activity Description
4111	Clearcut – Patch
4113	Clearcut – Stand
4114	Clearcut – with Reserves
4121	Shelterwood Preparatory Cut
4122	Seed Tree Preparatory Cut
4131	Shelterwood Seed Cut
4132	Seed Tree Seed Cut
4133	Shelterwood Seed Cut with Reserves
4134	Seed Tree Seed Cut with Reserves
4141	Shelterwood Removal Cut
4146	Shelterwood Final Cut
4148	Shelterwood Final Cut with Reserves
4151	Single Tree Selection Cut
4152	Group Selection Cut
4210	Improvements
4211	Liberation Cutting
4220	Thinning
4230	Sanitation Salvage
4231	Mortality Cut (Salvage)

4232	Sanitation

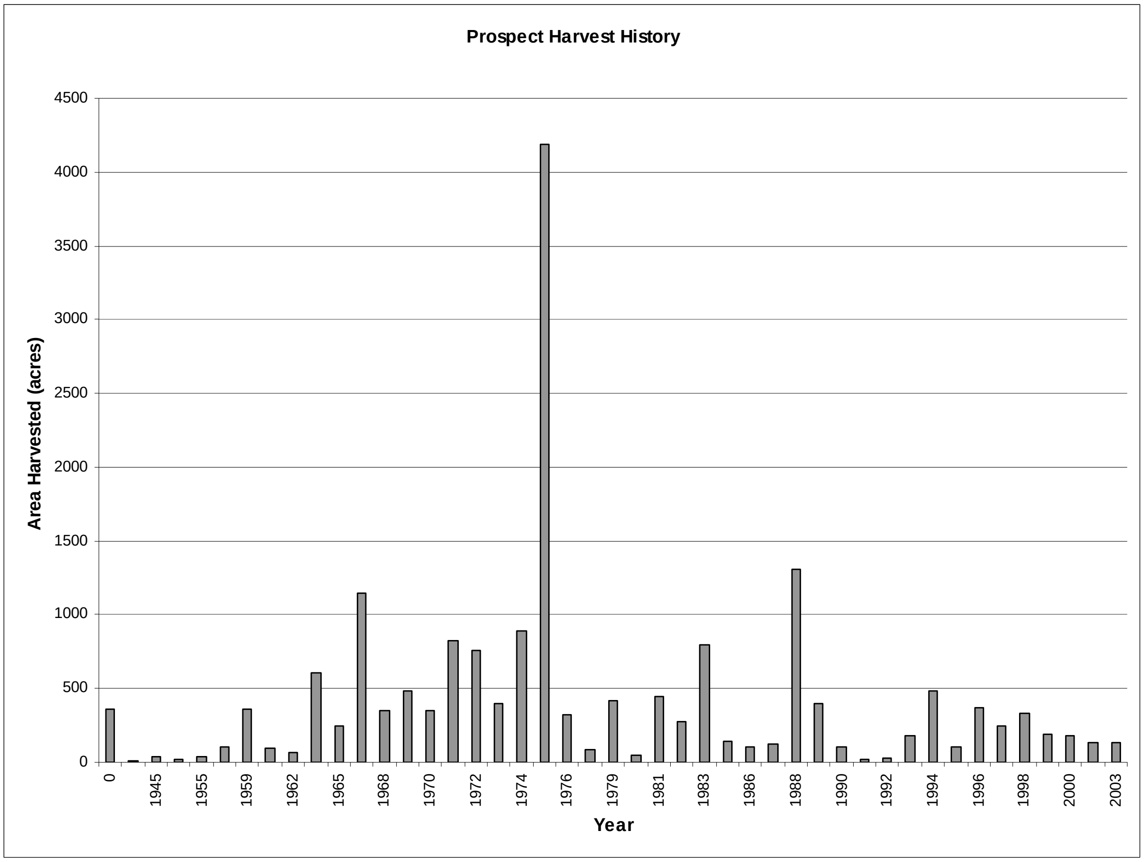

Figure A-1. Recorded Timber Harvest Activity in all Stands on National Forest in the Prospect Creek Watershed by Year

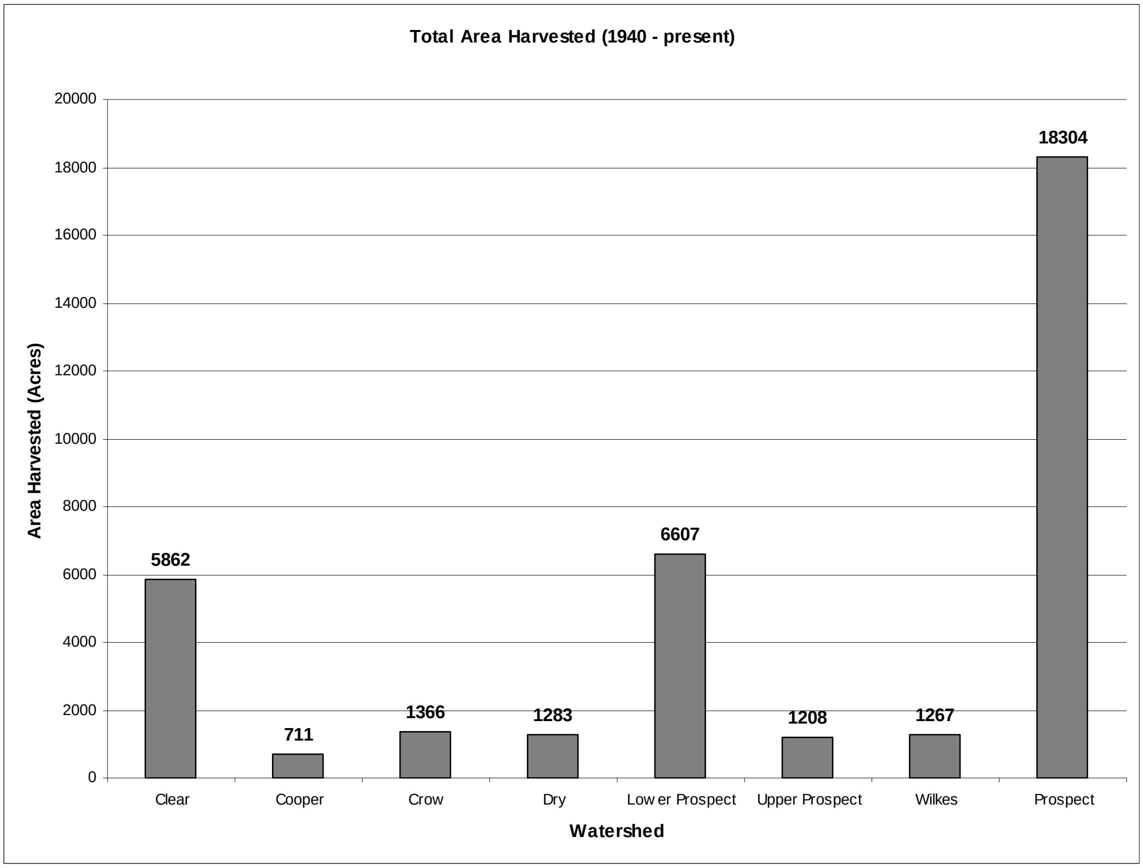

Figure A-2. Recorded Timber Harvest Activity in all Stands on National Forest in the Prospect Creek Watershed by HUC 6

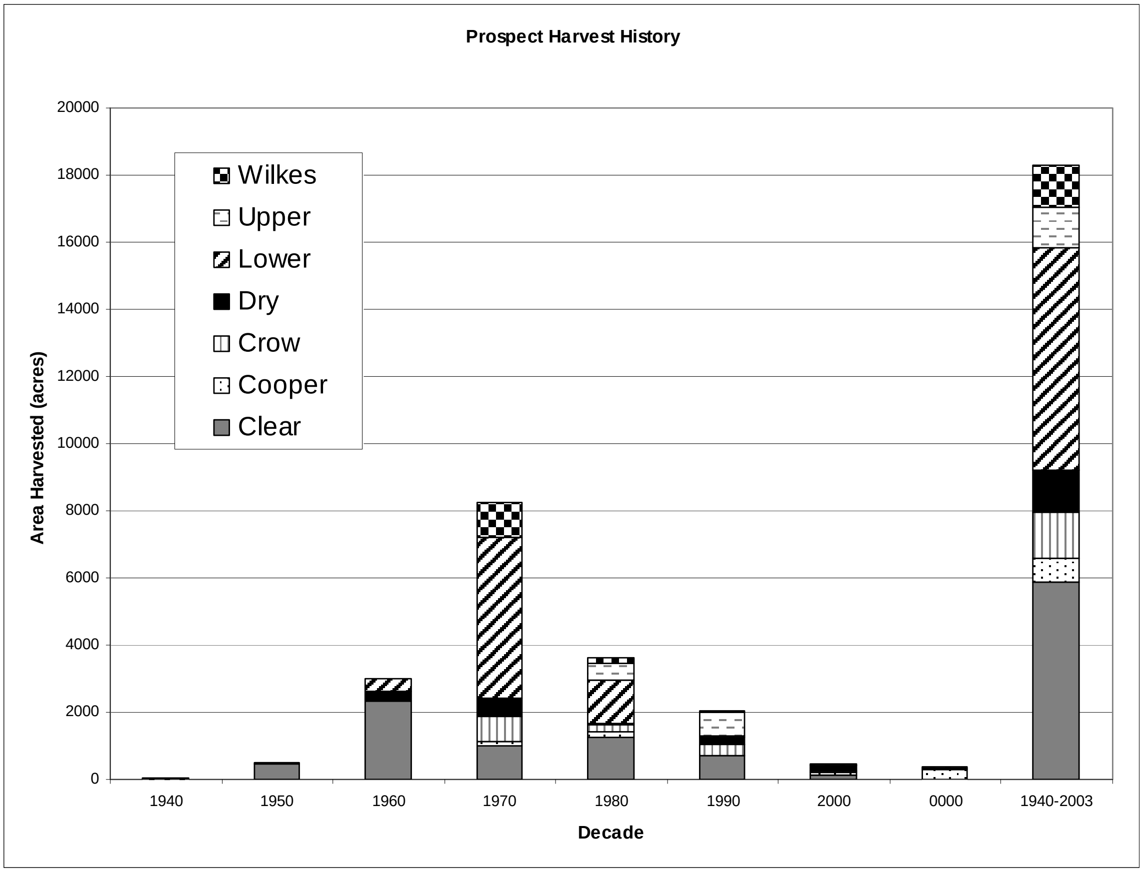

Figure A-3. Recorded Timber Harvest Activity in all Stands on National Forest in the Prospect Creek Watershed by Decade and by HUC 6

Table A-2. TSMRS Recorded Timber Harvest Activity in all Stands on National Forest in the Prospect Creek Watershed by Decade and by HUC 6

Area Harvested (Acres)	1940	1950	1960	1970	1980	1990	2000	0000	1940-2003	Total Area in Sub-Watershed (Acres)
Clear	0	479	2315	994	1257	694	123	0	5862	18304
Cooper	0	0	16	132	167	19	69	308	711	10112
Crow	0	0	0	732	196	340	64	34	1366	9472
Dry	0	0	312	556	55	188	172	0	1283	22912
Lower Prospect	48	39	359	4798	1273	61	12	17	6607	25792
Upper Prospect	0	0	0	0	495	713	0	0	1208	18944
Wilkes	0	0	0	1034	200	33	0	0	1267	10112
Total	**48**	**518**	**3002**	**8246**	**3643**	**2048**	**440**	**359**	**18304**	**115648**

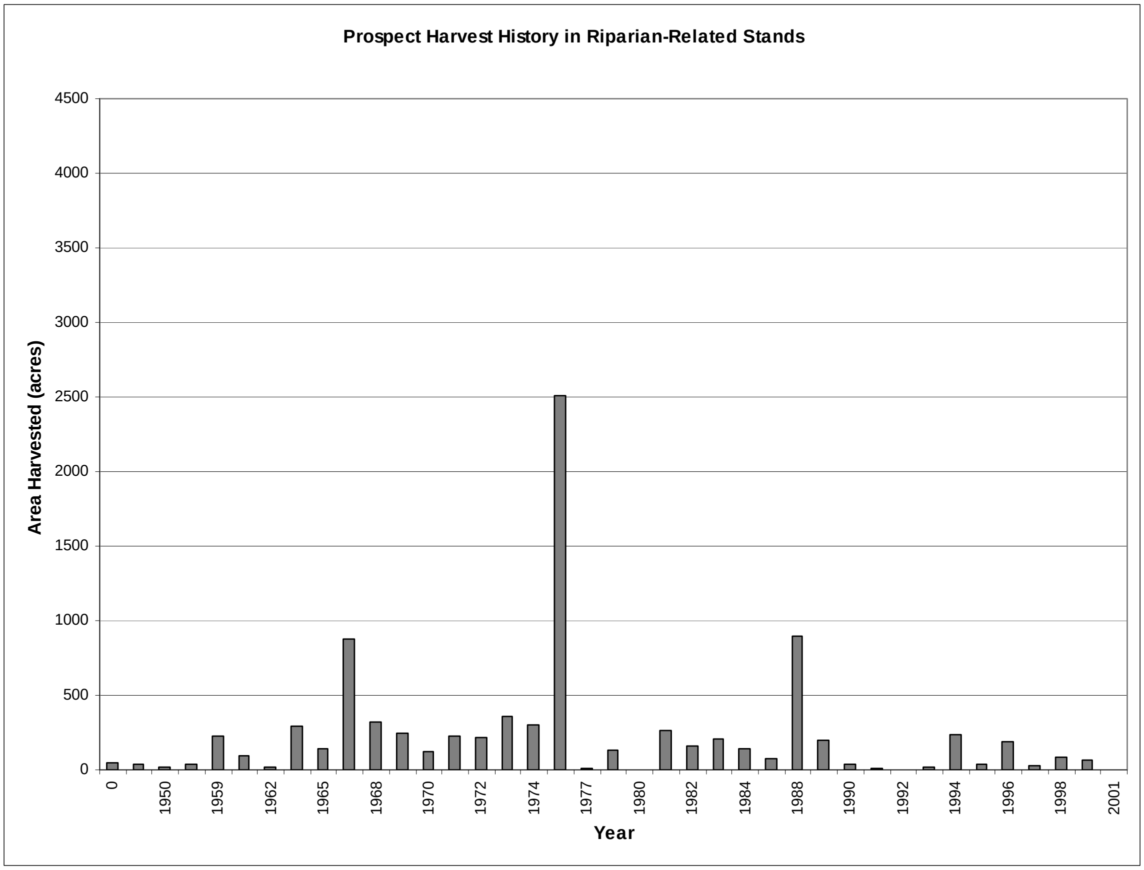

Figure A-4. Recorded Timber Harvest Activity in Riparian-Related Stands on National Forest in the Prospect Creek Watershed by Year

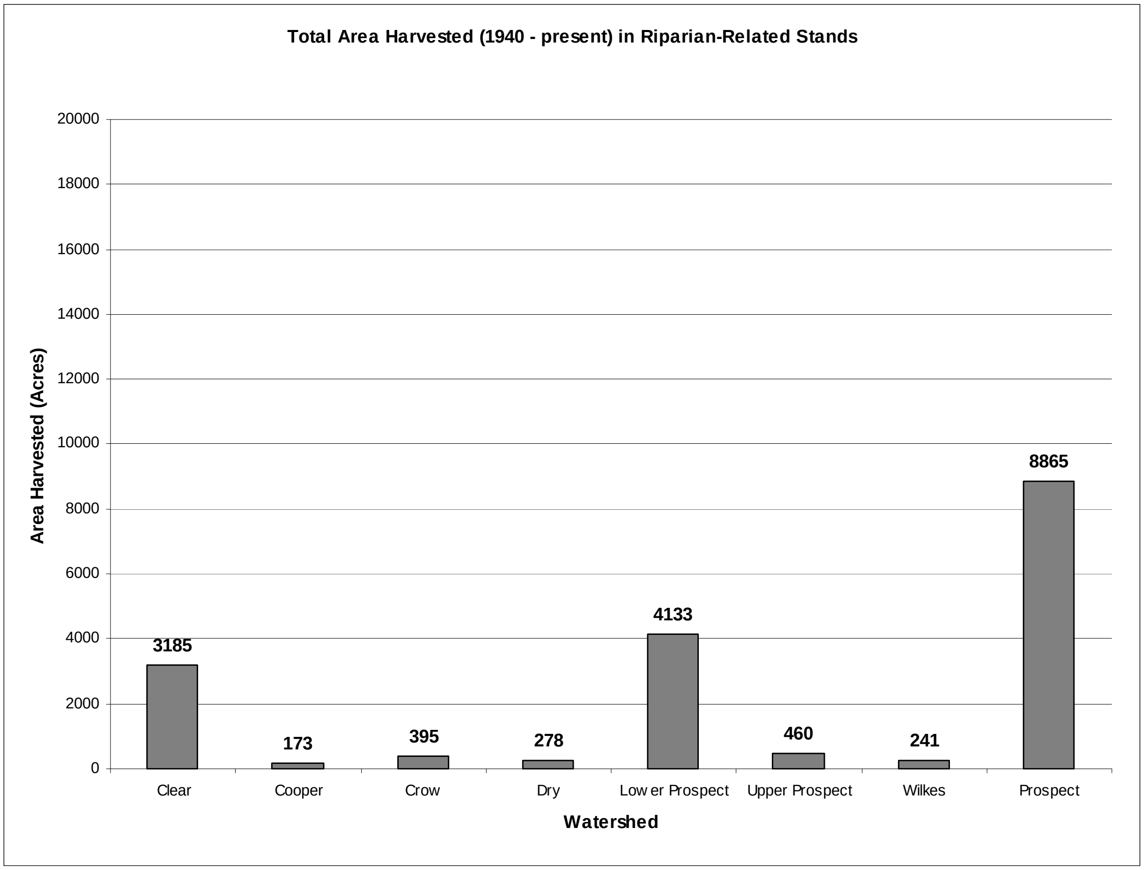

Figure A-5. Recorded Timber Harvest Activity in Riparian-Related Stands on National Forest in the Prospect Creek Watershed by HUC 6

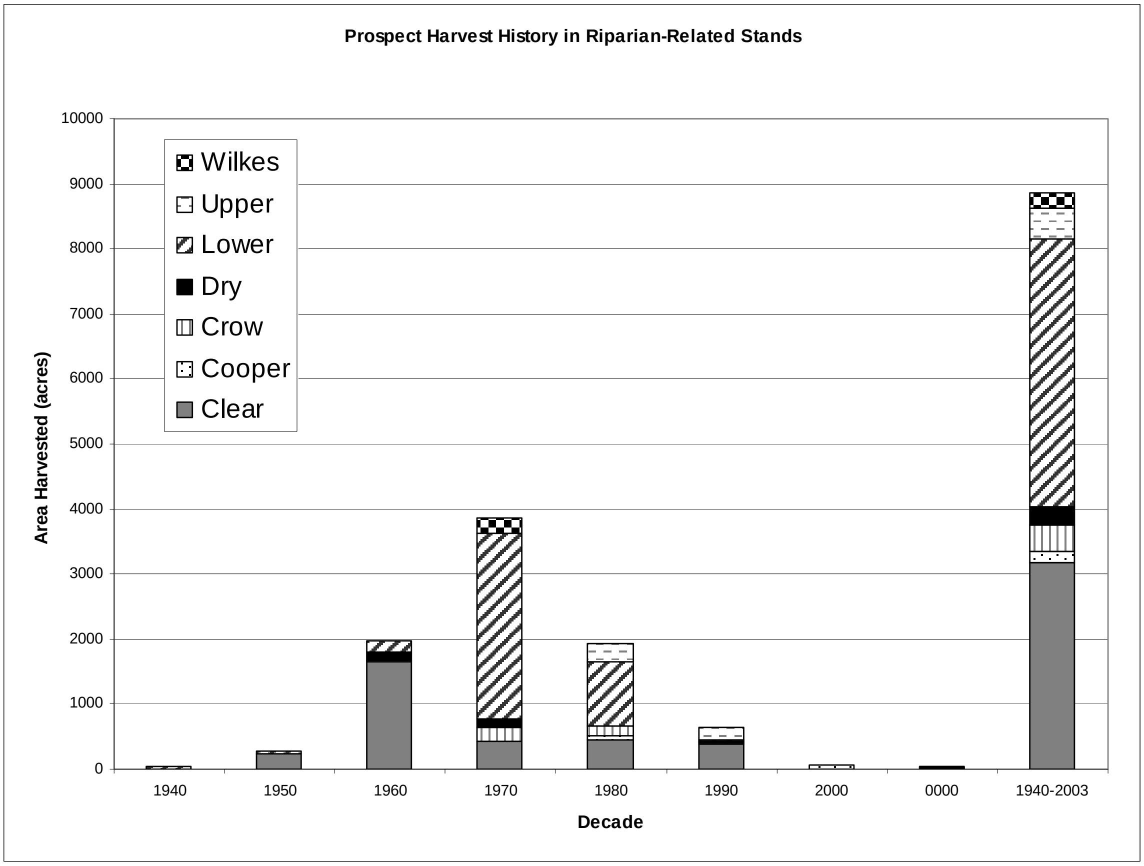

Figure A-6. Recorded Timber Harvest Activity in Riparian-Related Stands on National Forest in the Prospect Creek Watershed by Decade and by HUC 6

Table A-3: TSMRS Recorded Timber Harvest Activity (Acres*) in Riparian-Related Stands on National Forest in the Prospect Creek Watershed by Decade and by HUC 6

Area Harvested (Acres)	1940	1950	1960	1970	1980	1990	2000	0000	1940-2003	Total Area in Sub-Watershed (Acres+)
Clear	0	246	1657	435	453	394	0	0	3185	18304
Cooper	0	0	16	0	63	0	69	25	173	10112
Crow	0	0	0	204	147	18	4	22	395	9472
Dry	0	0	137	129	2	10	0	0	278	22912
Lower Prospect	39	39	169	2865	988	33	0	0	4133	25792
Upper Prospect	0	0	0	0	274	186	0	0	460	18944
Wilkes	0	0	0	235	6	0	0	0	241	10112
Total	**39**	**285**	**1979**	**3868**	**1933**	**641**	**73**	**47**	**8865**	**115648**

* Accomplishment acres recorded in TSMRS based on slope-length area.
+ Acres based on planar calculations from GIS layer of HUC 6 watershed boundaries.

Water Yield Analysis

The impact of increased water yield on sediment transport depends on both the sediment availability as well as the temporal distribution of the additional water on the flow hydrograph.

Data derived from closely monitored, harvested watersheds characterized by spring snowmelt runoff have shown that the flow augmentation tends to be concentrated on the rising limb and peak of that spring snowmelt runoff event (Troendle et al., 2001). An increase in stream flow during the snowmelt period can result in a significant increase in sediment transport capacity, as spring runoff conditions commonly constitute the channel forming discharge, characterized by active sediment transport and channel adjustment (Andrews and Nankervis, 1995).

If sediment is conveyed to the stream network, the increased sediment transport capacity caused by an increase in peak flows will result in an increased delivery of sediment to Prospect Creek. Alternatively, if sediment is not available for transport, increased transport energy will result in sediment sourcing downstream from the channel perimeter due to bank and bed scour (Troendle et al., 2001). Therefore, the most effective means of preventing significantly increased water yield and associated sediment production and delivery is to increase or maintain a given amount of vegetative cover.

The effects of vegetation removal from road building, timber harvest and fire on water yield is analyzed based on Equivalent Clearcut Areas (ECA) modeling. The analysis included harvest activity recorded in the USFS TSMRS as well as consideration of vegetation removed for roads. Harvest and other activity on private land and National Forest harvest activity not recorded in TSMRS were not included. The TSMRS activity codes considered in this analysis are included in **Table A-1.**

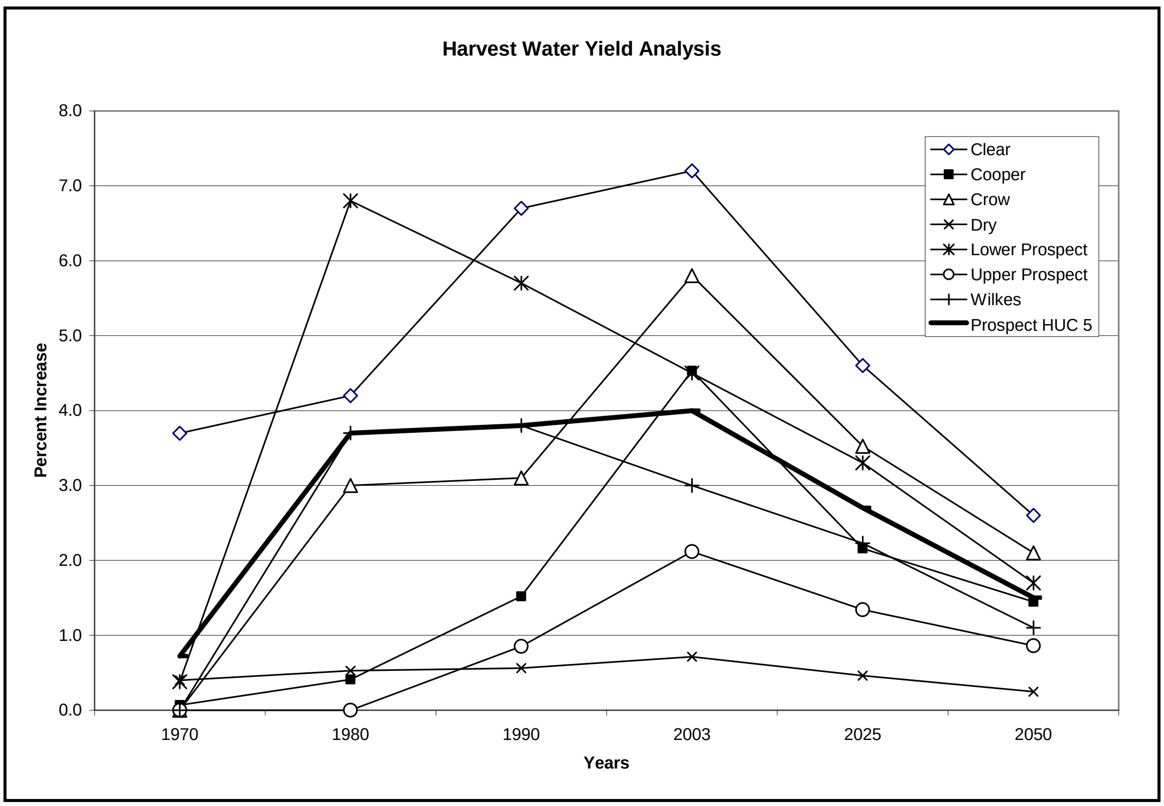

Figure A-7. Modeled Water Yield Increase (ECA Method) from Recorded Timber Harvest Activity on National Forest in the Prospect Creek Watershed by Decade and by HUC 6

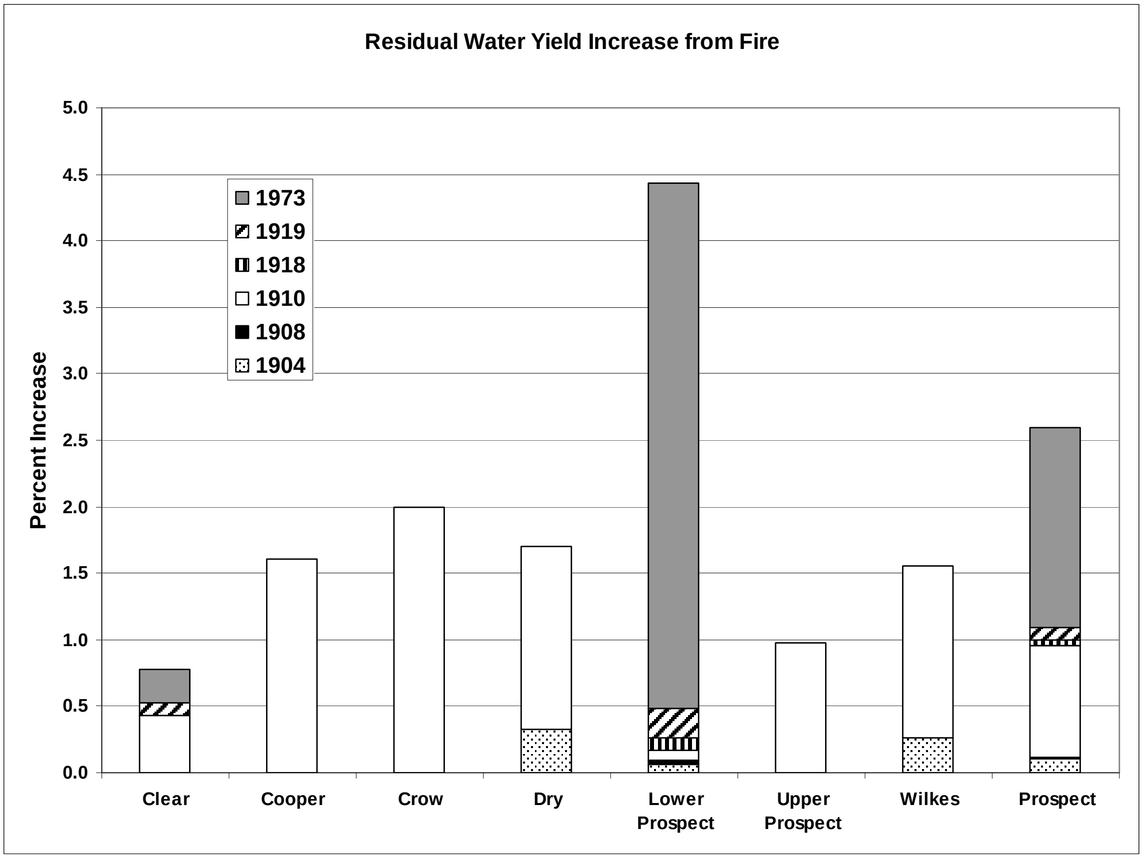

Figure A-8. Modeled Residual Water Yield Increase (ECA Method) from Recorded Fires in the Prospect Creek Watershed by HUC 6

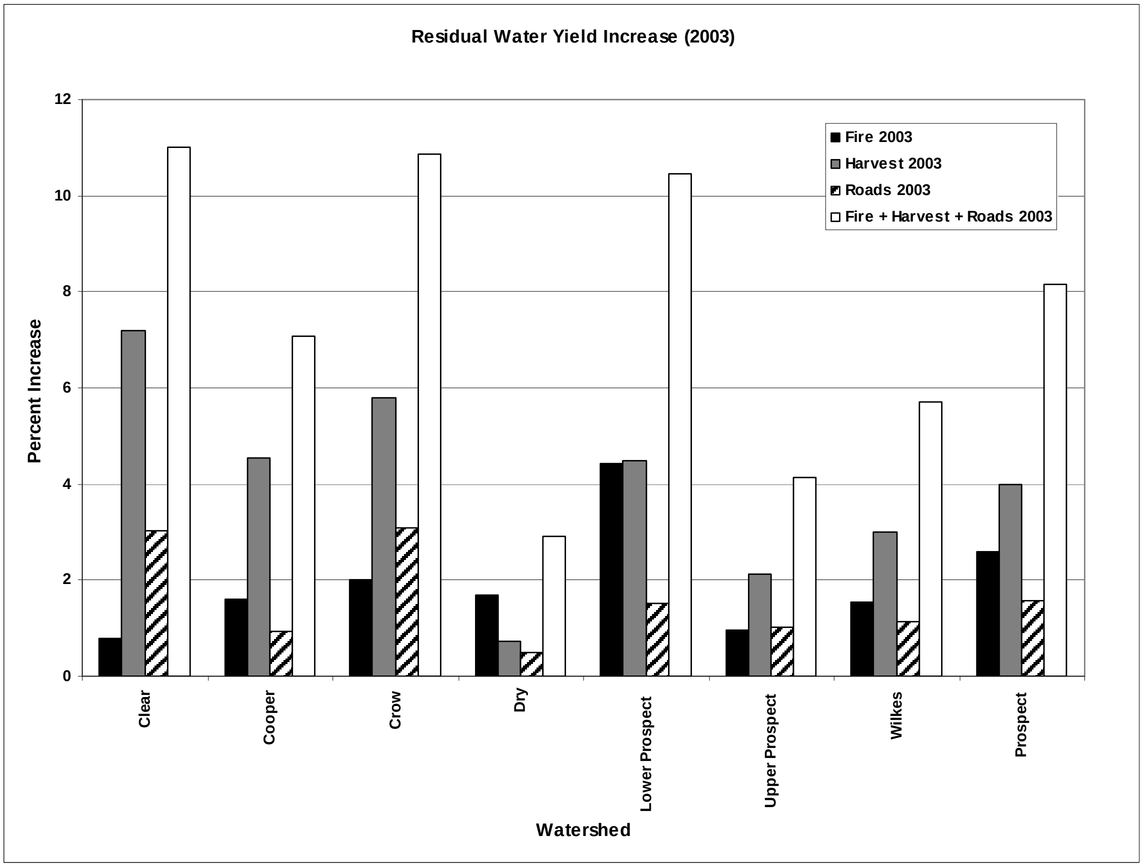

Figure A-9. Modeled Residual Water Yield Increase (ECA Method) from Recorded Roads, Fire, and Timber Harvest Activity in the Prospect Creek Watershed by HUC 6

References

Andrews, E. D. and J. M. Nankervis. 1995. Effective Discharge and the Design of Channel Maintenance Flows for Gravel-Bed Rivers: Natural and Anthropogenic Influences in Fluvial Geomorphology. *Natural and Anthropogenic Influences in Fluvial Geomorphology*. Geophysical Monograph (89): 151-164.

Troendle, C.A., D.L. Rosgen, S. Ryan, L. Porth, and J. Nankervis. 2001.Developing a "Reference" Sediment Transport Relationship. Presented at the Wildland Hydrology 7th Federal Interagency Sediment Conference, Vol. 2, pp. II, March 24-29, 2001 in Reno, Nev.

U.S. Forest Service. 2004. Forest Service Manual. FSM – 2400. Silvicultural Practices, Page 14. Washington, D.C.: U.S. Department of Agriculture.